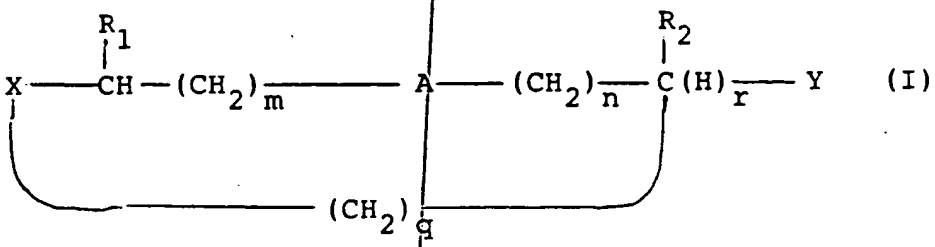
WE CLAIM:

1. A hapten of formula I

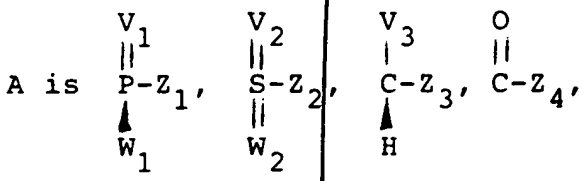


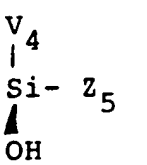
(I)

wherein

R_1 and R_2 may be the same or different and each is a side chain of a naturally occurring amino acid, a hydroxy containing side chain of a naturally occurring amino acid wherein said hydroxy group may be glycosylated, phosphorylated, sulphonylated or protected by a hydroxy protecting group, a primary amido containing side chain of a naturally occurring amino acid wherein said amido group may be glycosylated, or (C_1-C_4)alkyl, $-CH_2CH(CO_2H)_2$, $-(CH_2)_2S(O)CH_3$, $-(CH_2)_2S(O)_2CH_3$, $-(CH_2)_3NH_2$ or $-(CH_2)_3ONHC(=NH)NH_2$;

m, n and q may be be the same or different and each is 0 or an integer from 1 to 10 and r is 0 or 1 provided that if r is 1, then there is no bond between X and the carbon bonded to R_2;

A is 



V_1 is O or S;

V_2 is O or a lone pair of electrons;

V_3 and V_4 are OH or NH_2;

W_1 is OH, NH_2, SH or H;

W_2 is O or a lone pair of electrons;

X is hydrogen, oxygen, amino, amino protected by a protecting group selected from the group consisting of terminal amino protecting groups, amino bonded to the C terminus of a naturally occurring amino acid to form a peptide bond, amino bonded to the C terminus of a peptide to form a peptide bond, said amino acid and peptide being unprotected or protected by said protecting group, or X is alkene, (C_1-C_9)alkyl, (C_1-C_9)alkoxy, phenyl, phenoxy, cyclohexyl, phenylthio, phenylsulfinyl or phenylsulfonyl wherein the aforementioned phenyl groups may be unsubstituted or mono-, di- or trisubstituted by halogen, (C_1-C_4)alkyl, (C_1-C_4)alkoxy or (C_1-C_4)alkoxycarbonyl;

Y is hydrogen, carboxyl, carboxyl protected by a protecting group selected from the group consisting of terminal carboxyl protecting groups, a carbonyl bonded to the N terminus of a naturally occurring amino acid to form a peptide bond, carbonyl bonded to the N terminus of a peptide to form a peptide bond, said amino acid and peptide being

protected or unprotected by said protecting group, or Y is (C_1-C_9)alkyl, (C_1-C_9)alkoxy, phenyl, phenoxy, cyclohexyl, phenylthio, phenylsulfinyl or phenylsulfonyl wherein the aforementioned phenyl groups may be unsubstituted or mono-, di- or trisubstituted by halogen, (C_1-C_4)alkyl, (C_1-C_4)alkoxy or (C_1-C_4)alkoxycarbonyl;

and wherein

each of said substituents R_1, R_2, X and Y may be unbound or bound to one or more of said remaining substituents R_1, R_2, X and Y and if bound, then by a covalent bond or a linker moiety selected from the group consisting of $-(CH_2)_s-S-S-(CH_2)_t-$, $-(CH_2)_t-$, $-S-(CH_2)_t-S-$, $-(CH_2)_s-S-(CH_2)_t-$, $-(CH_2)_s-CH=CH-(CH_2)_t-$, $-(CH_2)_s-NH-CO-(CH_2)_t-$, $-(CH_2)_s-NH-(CH_2)_t-$ and $-(CH_2)_s-\text{Ø}-(CH_2)_t-$;

Z_1, Z_2, Z_3, Z_4, Z_5 and Z_6 may be unbound or bound to said linker moiety; and if unbound Z_1 is O, NH, CH_2 or S, Z_2 is O, NH or CH_2, Z_3 is CH_2, Z_4 is CF_2 or CF_2CO and Z_5 and Z_6 are O or CH_2 provided that if Z_1 is O or NH and if V_1 is O and if W_1 is OH, then r is either 0 or r is 1 and at least one of said substituents R_1, R_2, X or Y is bound to one or more of said remaining substituents R_1, R_2, X and Y and further provided that if Z_3 is CH_2 and if V_3 is OH, then r is either 0 or r is 1 and at least one of said substituents R_1, R_2, X or Y is bound to one or more of said remaining substituents R_1, R_2, X and Y; and if bound Z_1 and Z_2 are N or CH, Z_4 is CF or CFCO and Z_3, Z_5 and Z_6 are CH and further provided that if Z_1, Z_2,

Z_3, Z_4, Z_5 or Z_6 is bound to said linker moiety, it is covalently bound to said linker moiety by substitution at an appropriate atom of said linker moiety; and

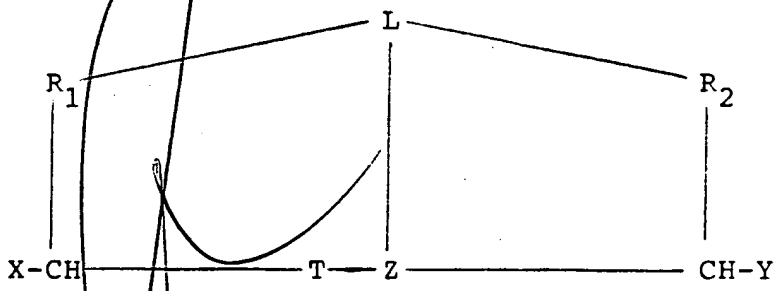
s and t may be the same or different and each is 0 or an integer from 1 to 10 unless the linker moiety is $-(CH_2)_t-$ in which case t is an integer from 1 to 10.

2. An immunogen capable of eliciting a catalytic antibody comprising:

(a) a hapten of formula I as claimed in claim 1; and

(b) a suitable carrier molecule.

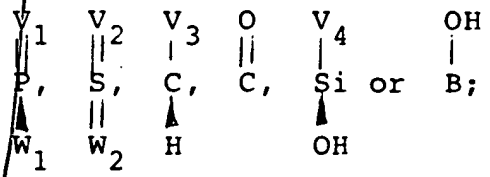
3. A hapten of claim 1 having formula IA



(IA)

wherein

R_1, R_2, X and Y and are as defined in claim 1;

T is  or B;

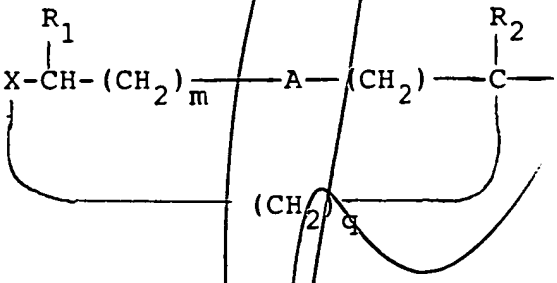
V_1, V_2, V_3, V_4, W_1 and W_2 are as defined in claim 1;

Z is Z_1, Z_2, Z_3, Z_4, Z_5 or Z_6 as defined in claim 1; and

L is N or CH in the linker moiety as defined in claim 1.

4. The hapten of claim 3 wherein in formula IA, R_1 and R_2 are $-CH_2-$ or $-CH_2CH_2-$ and the linker moiety is $-CH_2-CO-N-CH_2-$, $-CH_2-N-CH_2-$, $-CH_2-CH-S-$ or -ortho-phenyl-$CH-CH_2-$.

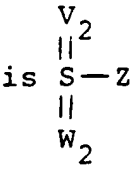
5. A hapten of claim 1 having formula IB,



(IB)

wherein R_1, R_2, X, Y, A, m, n and q are defined as in claim 1.

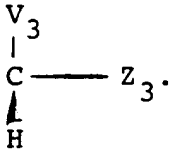
6. A hapten of claim 1 wherein formula I,

A is  .

7. A hapten of claim 6 wherein V_2 and W_2 are O and Z_2 is NH.

8. The hapten of claim 7 which is aminomethanesulfonamidylalanyl acid.

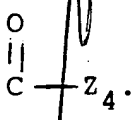
9. A hapten of claim 1 wherein formula I, A is



10. A hapten of claim 9 wherein V_3 is OH and Z_3 is CH_2.

11. A hapten of claim 9 wherein V_3 is NH_2 and Z_3 is CH_2.

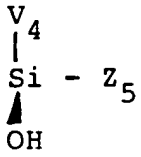
12. A hapten of claim 1 wherein A is



13. A hapten of claim 12 wherein Z_4 is CF_2.

14. The hapten of claim 13 which is 5-(serinyl)amino 3, 3 difluoro 4-oxo 6-hydroxy heptanoic acid.

15. The hapten of claim 1 wherein A is

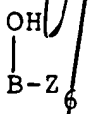


16. A hapten of claim 15 wherein V_4 is OH and Z_5 is O.

17. A hapten of claim 16 wherein V_4 is OH and Z_5 is CH_2.

18. The hapten of claim 17 which is 3-(aminomethyldihydroxysilyl) propionic acid.

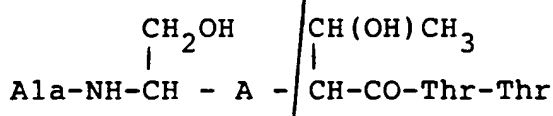
19. A hapten of claim 1 wherein A is

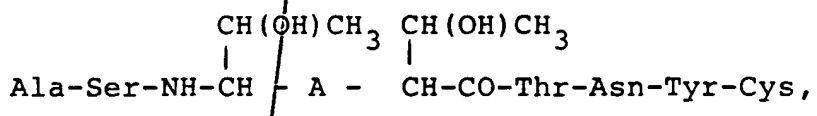


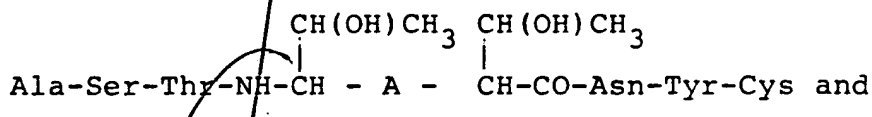
20. A hapten of claim 19 wherein Z_6 is O.

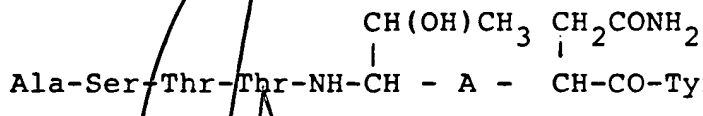
21. The hapten of claim 20 which is (S)-lactate-1-(R)-amino-2-phenylethane boronate.

22. A hapten according to claim 1 which is selected from the group consisting of



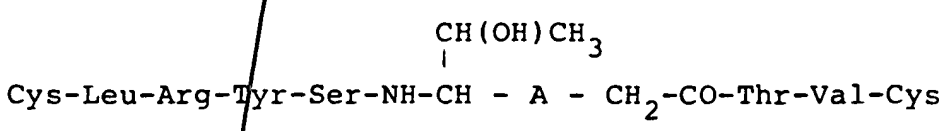






wherein A is as defined in claim 1.

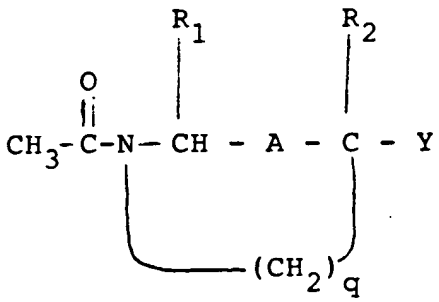
23. A hapten according to claim 1 which is



wherein A is as defined in claim 1.

24. A hapten according to claim 23 having a β-turn configuration mimicking the configuration of native protein wherein the sulfur atoms in the two terminal cysteine residues are joined to form a disulphide bridge.

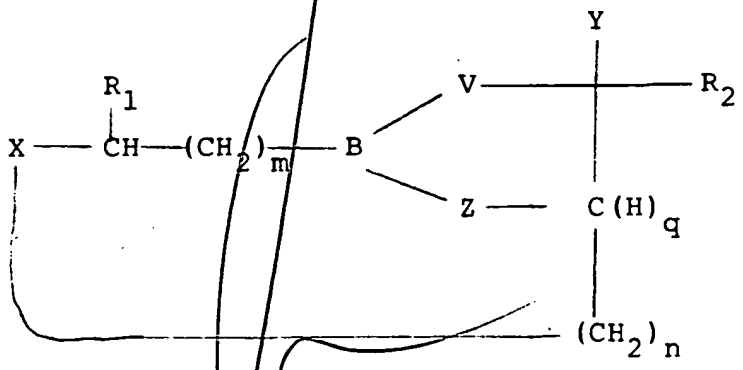
25. A hapten according to claim 5 of formula IC



(IC)

wherein R_1, R_2, A, Y and q are as defined in claim 5.

26. A boron-containing hapten of formula II



(II)

wherein

R_1 and R_2 may be the same or different and each is a side chain of a naturally occurring amino acid, a hydroxy containing side chain of a naturally occurring amino acid wherein said hydroxy group may be glycosylated,

phosphorylated, sulphonylated or protected by a hydroxy protecting group, a primary amido containing side chain of a naturally occurring amino acid wherein said amino group may be glycosylated or (C_1-C_4)alkyl, $-CH_2CH(CO_2H)_2$, $-(CH_2)_2S(O)CH_3$, $-(CH_2)_2S(O)_2CH_3$, $-(CH_2)_3NH_2$ or $-(CH_2)_3ONHC(=NH)NH_2$;

V is O, CH_2 or NH;

X is hydrogen, oxygen, amino, amino protected by a protecting group selected from the group consisting of terminal amino protecting groups, amino bonded to the C terminus of a naturally occurring amino acid to form a peptide bond, amino bonded to the C terminus of a peptide to form a peptide bond, said amino acid and peptide being unprotected or protected by said protecting group, or X is alkene, (C_1-C_9)alkyl, (C_1-C_9)alkoxy or phenyl, phenoxy, cyclohexyl, phenylthio, phenylsulfinyl or phenylsulfonyl wherein the aforementioned phenyl groups may be unsubstituted or mono-, di- or trisubstituted by halogen, (C_1-C_4)alkoxy or (C_1-C_4)alkoxycarbonyl;

Y is hydrogen, carboxyl, carboxyl protected by a protecting group selected from the group consisting of terminal carboxyl protecting groups, a carbonyl bonded the N terminus of a naturally occurring amino acid to form a carbonyl bonded to the N terminus of a peptide to form a peptide bond, said amino acid and peptide being protected or unprotected by said protecting group, or Y is (C_1-C_9)alkyl, (C_1-C_9)alkoxy, or phenyl phenoxy, cyclohexyl, phenylthio,

phenylsulfinyl or phenylsulfonyl wherein the aforementioned phenyl groups may be unsubstituted or mono-, di- or trisubstituted by halogen, (C_1-C_4)alkyl, (C_1-C_4)alkoxy or (C_1-C_4)alkoxycarbonyl; and wherein

Z is O, CH_2 or NH;

m is 0 or an integer from 1 to 10;

n is 0 or 1; and

q is 1 or 2 provided that if q is 2, then there is no bond between X and the carbon bond to Z.

27. The hapten of claim 26 wherein m is 0 and q is 2.

28. The hapten of claim 27 which is (R)-2-hydroxymethyl-2-hydroxypropionic acid diol-1-amino-2-phenylethaneboronate.

29. A hapten according to claim 26 wherein

R_1 is selected from the group consisting of CH_2OH and $CH(OH)CH_3$,

R_2 is selected from the group consisting of $CH(OH)CH_3$ and CH_2CONH_2,

X is selected from the group consisting of amino bonded to the C terminus of alanine, amino bonded to the C terminus of serine in the dipeptide Ala-Ser, amino bonded to the C terminus of threonine in the tripeptide

Ala-Ser-Thr and amino bonded to the C terminus of threonine in the polypeptide Ala-Ser-Thr-Thr and

Y is selected from the group consisting of carbonyl bonded to the N terminus of theronine in the polypeptide Thr-Thr-Asn-Tyr-Cys, carbonyl bonded to the N terminus of threonine in the polypeptide Thr-Asn-Tyr-Cys, carbonyl bonded to the N terminus of asparagine in the tripeptide Asn-Tyr-Cys and carbonyl bonded to the N terminus of tyrosine in the dipeptide Tyr-Cys.

30. A hapten according to claim 26 wherein R_1 is $CH(OH)CH_3$, R_2 is H, X is amino bonded to the C terminus of serine in the polypeptide Cys-Leu-Arg-Tyr-Ser and Y is carbonyl bonded to the N terminus of threonine in the tripeptide Thr-Val-Cys.

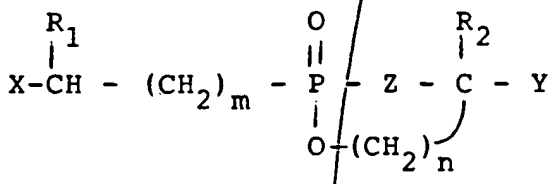
31. A hapten according to claim 30 having a β-turn configuration mimicking the configuration of native protein wherein the sulfur atoms in the two terminal cysteine residues are joined to form a disulphide bridge.

32. An immunogen capable of eliciting a catalytic antibody comprising:

(a) a hapten of formula II as defined in claim 27; and

(b) a suitable carrier molecule.

33. A phosphous containing hapten of formula III



(III)

wherein

R_1 and R_2 may be the same or different and each is a side chain of a naturally occurring amino acid, a hydroxy containing side chain of a naturally occurring amino acid wherein said hydroxy group may be glycosylated, phosphorylated, sulphonylated or protected by a hydroxy protecting group, a primary amido containing side chain of a naturally occurring amino acid wherein said amido group may be glycosylated or (C_1-C_4)alkyl, $-CH_2CH(CO_2H)_2$, $-(CH_2)_2S(O)CH_3$, $-(CH_2)_2S(O)_2CH_3$, $-(CH_2)_3NH_2$ or $-(CH_2)_3ONHC(=NH)NH_2$;

X is hydrogen, amino, amino protected by a protecting group selected from the group consisting of terminal amino protecting groups, amino bonded to the C terminus of a naturally occurring amino acid to form a peptide bond, amino bonded to the C terminus of a peptide to form a peptide bond, said amino acid and peptide being unprotected or protected by said protecting group, or X is alkene, (C_1-C_9)alkyl, (C_1-C_9)alkoxy, or phenyl, phenoxy, cyclohexyl, phenylthio, phenylsulfinyl or phenylsulfonyl wherein the aforementioned phenyl groups may be unsubstituted

or mono-, di- or trisubstituted by halogen, (C_1-C_4)alkyl, (C_1-C_4)alkoxy or (C_1-C_4)alkoxycarbonyl;

Y is hydrogen, carboxyl, carboxyl protected by a protecting group selected from the group consisting of terminal carboxyl protecting groups, a carbonyl bonded to the N terminus of a naturally occurring amino acid to form a peptide bond, carbonyl bonded to the N terminus of a peptide to form a peptide bond, said amino acid and peptide being protected or unprotected by said protecting group, or Y is (C_1-C_9)alkyl, (C_1-C_9)alkoxy, or phenyl, phenoxy, cyclohexyl, phenylthio, phenylsulfinyl or phenylsulfonyl wherein the aforementioned phenyl groups may be unsubstituted or mono-, di- or trisubstituted by halogen, (C_1-C_4)alkyl, (C_1-C_4)alkoxy or (C_1-C_4)alkoxycarbonyl;

Z is O or NH; and

m and n may be the same or different and each is 0 or an integer from 1 to 10.

34. An immunogen capable of eliciting a catalytic antibody comprising:

(a) a hapten of formula III as defined in claim 33; and

(b) a suitable carrier molecule.

35. A catalytic antibody elicited by an antigen comprising the hapten of claim 1.

36. A catalytic antibody elicited by an antigen comprising the hapten of claim 26.

37. A catalytic antibody elicited by an antigen comprising the hapten of claim 33.

38. A catalytic antibody which can catalyze a chemical reaction of interest and which is elicited through in vitro or in vivo techniques by an antigen comprising the hapten of claim 1, said catalytic antibody having been prepared by a process comprising the steps of:

(a) exposing cells capable of producing antibodies to said antigen and thereby generating antibody producing cells;

(b) hybridizing said antibody producing cells with myeloma cells and thereby generating a plurality of hybridoma cells each producing monoclonal antibodies; and

(c) screening said plurality of monoclonal antibodies to identify a monoclonal antibody which catalyzes said chemical reaction of interest.

39. A catalytic antibody which can catalyze a chemical reaction of interest and which is elicited through in vitro or in vivo techniques by an antigen comprising the hapten of claim 26, said catalytic antibody having been prepared by a process comprising the steps of:

(a) exposing cells capable of producing antibodies to said antigen and thereby generating antibody producing cells;

(b) hybridizing said antibody producing cells with myeloma cells and thereby generating a plurality of hybridoma cells each producing monoclonal antibodies; and

(c) screening said plurality of monoclonal antibodies to identify a monoclonal antibody which catalyzes said chemical reaction of interest.

40. A catalytic antibody which can catalyze a chemical reaction of interest and which is elicited through in vitro or in vivo techniques by an antigen comprising the hapten of claim 33, said catalytic antibody having been prepared by a process comprising the steps of:

(a) exposing cells capable of producing antibodies to said antigen and thereby generating antibody producing cells;

(b) hybridizing said antibody producing cells with mecloma cells and thereby generating a plurality of hybridoma cells each producing monoclonal antibodies; and

(c) screening said plurality of monoclonal antibodies to identify a monoclonal antibody which catalyzes said chemical reaction of interest.

41. A method for producing catalytic antibodies which can catalyze a chemical reaction of interest and which are elicited through in vitro or in vivo techniques by an antigen comprising the hapten of claim 1, wherein said method comprises the steps of:

(a) exposing cells capable of producing antibodies to said antigen and thereby generating antibody producing cells;

(b) hybridizing said antibody producing cells with myeloma cells and thereby generating a plurality of hybridoma cells each producing monoclonal antibodies; and

(c) screening said plurality of monoclonal antibodies to identify a monoclonal antibody which catalyzes said chemical reaction of interest.

42. A method for producing catalytic antibodies which can catalyze a chemical reaction of interest and which are elicited through in vitro or in vivo techniques by an antigen comprising the hapten of claim 26, wherein said method comprises the steps of:

(a) exposing cells capable of producing antibodies to said antigen and thereby generating antibody producing cells;

(b) hybridizing said antibody producing cells with myeloma cells and thereby generating a plurality of hybridoma cells each producing monoclonal antibodies; and

(c) screening said plurality of monoclonal antibodies to identify a monoclonal antibody which catalyzes said chemical reaction of interest.

43. A method for producing catalytic antibodies which can catalyze a chemical reaction of interest and which are elicited through in vitro or in vivo techniques by an antigen comprising the hapten of claim 33, wherein said method comprises the steps of:

(a) exposing cells capable of producing antibodies to said antigen and thereby generating antibody producing cells;

(b) hybridizing said antibody producing cells with myeloma cells and thereby generating a plurality of hybridoma cells each producing monoclonal antibodies; and

(c) screening said plurality of monoclonal antibodies to identify a monoclonal antibody which catalyzes said chemical reaction of interest.

44. A method for catalyzing the cleavage or formation of a peptide linkage or an ester bond in a molecule comprising contacting said molecule with an effective amount of a catalytic antibody elicited by an antigen comprising the hapten of claim 1.

45. A method for catalyzing the cleavage or formation of a peptide linkage or an ester bond in a molecule comprising contacting said molecule with an effective amount of a catalytic antibody elicited by an antigen comprising the hapten of claim 26.

46. A method for catalyzing the cleavage or formation of a peptide linkage or an ester bond in a molecule comprising contacting said molecule with an effective amount of a catalytic antibody elicited by an antigen comprising the hapten of claim 33.

47. A method for catalyzing the cleavage or formation of a specific peptide linkage or an ester bond within a specific amino acid sequence of a molecule which comprises contacting said molecule with an effective amount of a catalytic antibody elicited with a hapten of claim 1, said hapten having complimentarity with said specific amino acid sequence.

48. A method for catalyzing the cleavage or formation of a specific peptide linkage or an ester bond within a specific amino acid sequence of a molecule which comprises contacting said molecule with an effective amount of a catalytic antibody elicited with a hapten of claim 26, said hapten having complimentarity with said specific amino acid sequence.

49. A method for catalyzing the cleavage or formation of a specific peptide linkage or an ester bond within a specific amino acid sequence of a molecule which comprises contacting said molecule with an effective amount of a catalytic antibody elicited with a hapten of claim 33, said hapten having complimentarity with said specific amino acid sequence.

50. A method for treating acquired immune deficiency syndrome by inhibiting human immunodificiency virus which comprises treating a patent with an effective amount of a catalytic antibody elicited using a hapten of claim 22.

51. A method for treating acquired immune deficiency syndrome by inhibiting human immunodificiency virus which comprises treating a patent with an effective amount of a catalytic antibody elicited using a hapten of claim 29.

52. A method for treating acquired immune deficiency syndrome by inhibiting human immunodificiency virus which comprises treating a patent with an effective amount of a catalytic antibody elicited using a hapten of claim 33.

53. A method for treating hypertension by inhibiting human renin activity which comprises treating a

patient with an effective amount of a catalytic antibody elicited using a hapten of claim 23.

54. A method for treating hypertension by inhibiting human renin activity which comprises treating a patient with an effective amount of a catalytic antibody elicited using a hapten of claim 30.

55. A method for treating hypertension by inhibiting human renin activity which comprises treating a patient with an effective amount of a catalytic antibody elicited using a hapten of claim 33.